TACOM
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Close Combat Armaments Center

Manufacturing Process Development For the OCSW Warhead

PRESENTED BY
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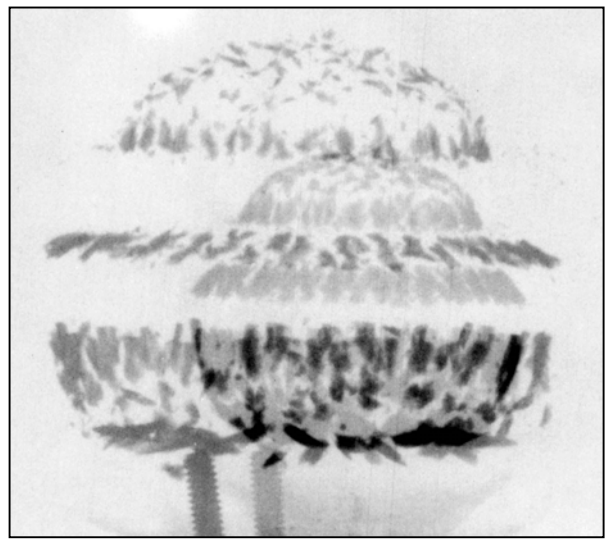
AMSTA-AR-CCL-B



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Abstract

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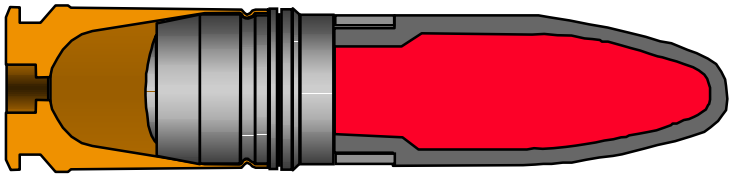
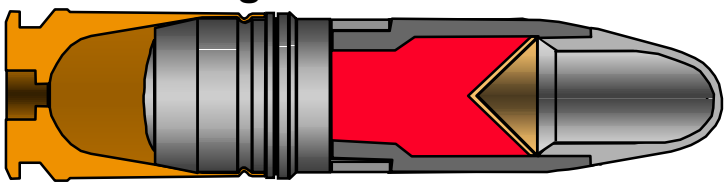
OCSW BALLISTICALLY MATCHED 25MM AMMUNITION FAMILY

HE Cartridge



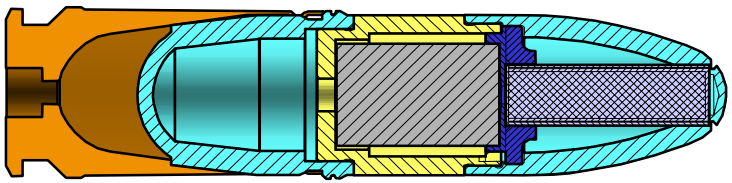
- Prescored Steel Warhead
- LX-14 High Explosive
- Defeats PASGT Vest & Helmet

AP Cartridge



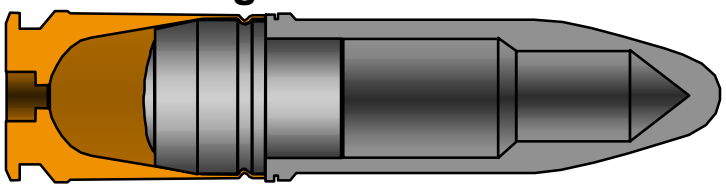
- 51mm RHA (Threshold)
- 51mm HHA (Goal)

TP-S Cartridge



- Flash Bang Training

TP Cartridge



- Two-Piece Projectile
- Integral Rotating Band

Program

- **Objective** - Develop a cost effective manufacturing process for the OCSW warhead while maintaining warhead efficiency
- **Process** – Evaluate OCSW warheads produced using conventional warhead manufacturing processes for fragmentation and relative cost
  - Natural fragmenting forged warheads
  - Embossed blank, cup and draw (BCD) warheads
- **Progress**
  - FY98 Forged HF-1 steel warheads
  - FY99 Forged (Hot/Cold) AISI 9260, 1340, 1090, 4340 and HF-1
  - FY00 Forged 1340 with nose embossing
  - FY01 BCD process with AISI 1018 and 1040

FY98 Effort

- HF-1 Steel developed during the late 60's as a "naturally fragmenting" material for artillery and mortar shells
- High Carbon (1.0-1.15%), Silicon (0.7-1.0%) and Manganese (1.6-1.9%) content lead to good natural fragmentation
- Fragmentation is controlled by processing and heat treatment
- Warheads hot forged at 2000°F
- 3 heat treatments evaluated
  - Austenitized, Quench and Temper
  - Normalize and Temper
  - Temper

Weight Group	Number of Fragments	Weight (Grains)	Average Weight
< .2		144.9	
.2< <.5	323	92.4	0.29
.5< <1.0	153	98.4	0.64
1.0< <1.5	32	36.5	1.14
1.5< <2.0	12	21.8	1.82
2.0<	16	59.7	3.73

Fragmentation Testing

- Warheads were melt cast with Octal (70% HMX 30% TNT)
- Explosive initiated via Risi RP3 detonator and PBXN-5 booster pellet
- Warheads tested using saw dust and water recovery methods
  - Water – Warhead placed inside of air filled balloon inside tank of water. Fragments magnetically recovered from water.
  - Saw Dust – Warhead placed inside a paper container inside tank of saw dust. Fragments magnetically recovered from saw dust.

Fragmentation Testing

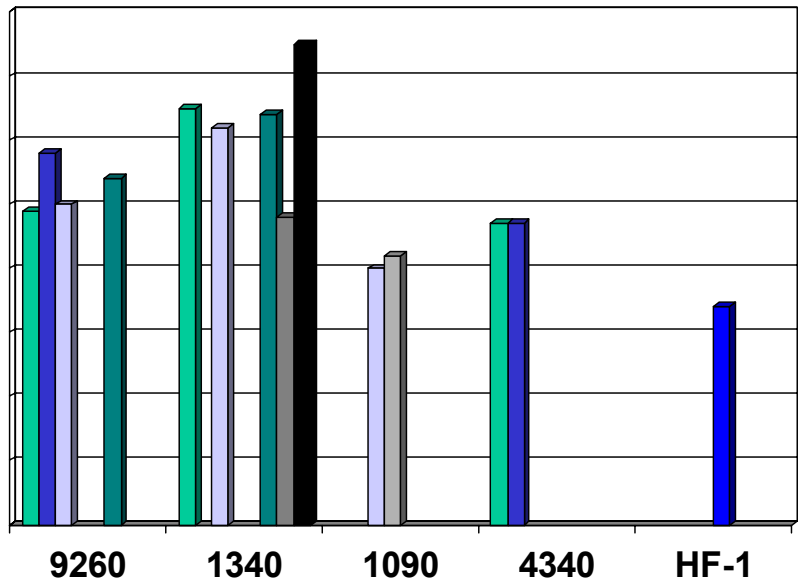
General Dynamics – Ordnance and Tactical Systems (GD-OTS)
Fragment Recovery Water Tank

FY99 Effort

- A matrix of warheads were forged from 5 materials and various heat treats
  - **AISI 9260** - Forged and Tempered, Normalized and Tempered, Austenitized Oil Quenched and Tempered and Intermediate Austenitized Oil Quenched and Tempered
  - **AISI 1340** - Forged and Tempered, Austenitized Oil Quenched and Tempered, Intermediate Austenitized Oil Quenched and Tempered, Cold Forged and Stress Relieved and Cold Forged Austenitized Oil Quenched and Tempered
  - **AISI 1090** - Austenitized Oil Quenched and Tempered and Austenitized Water Quenched and Tempered
  - **AISI 4340** - Forged and Tempered and Normalized and Tempered
  - **HF-1** – High Temp Austenitized Air Cooled and Tempered
- Heat treatments were chosen to obtain 100ksi min yield strength and while varying the warhead microstructure

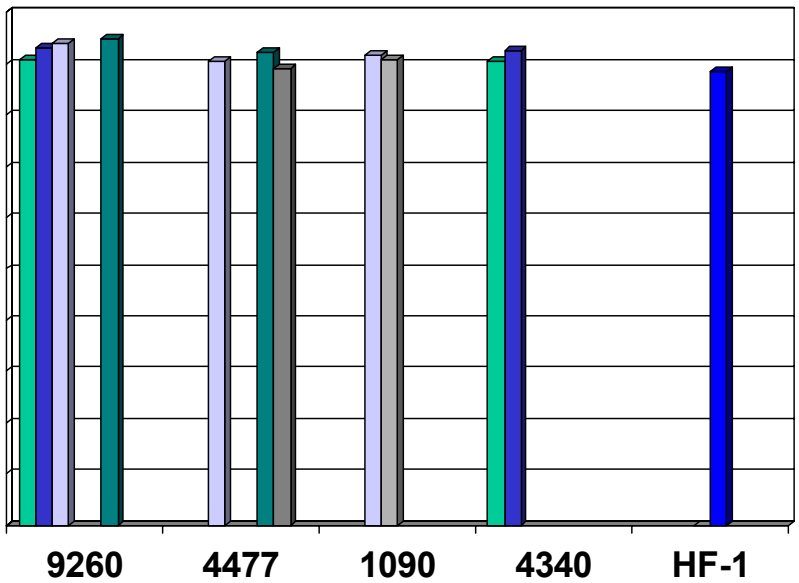
Fragmentation Testing

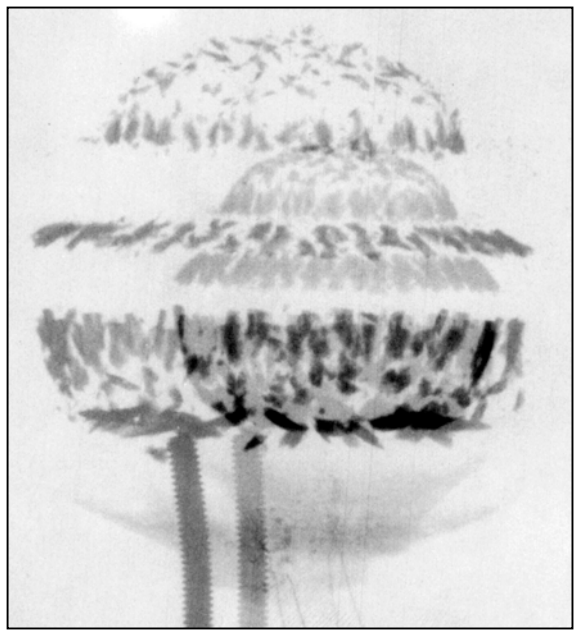
- Warheads were melt cast with Octal (70% HMX 30% TNT)
- Explosive initiated via Risi RP3 detonator and PBXN-5 booster pellet
- Fragments were recovered in saw dust and magnetically retrieved
- 1340 cold forged, austenitized with oil quench was found to have the best fragmentation



Frag Velocity Testing

- Warheads were melt cast with Octal (70% HMX 30% TNT)
- Explosive initiated via Risi RP3 detonator and PBXN-5 booster pellet
- Fragment velocity measured using dual flash x-ray averaging 4500ft/sec



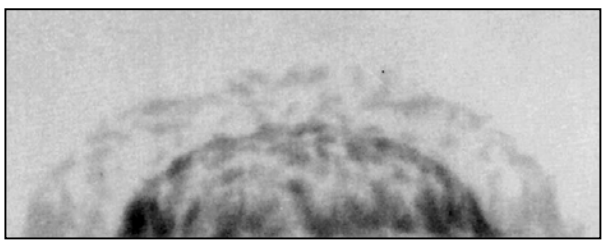


FY00 Effort

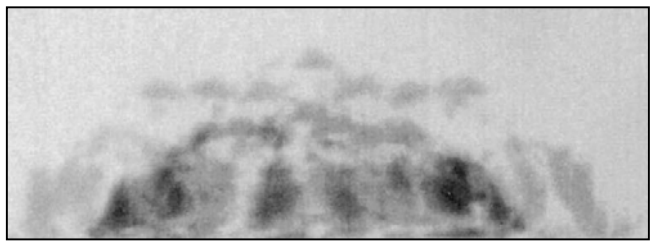
- Warheads cold forged from AISI 1340
- Embossing in nose, 60° symmetric groove, pressed in after forging to a depth of 0.016”
- Warheads were press loaded with LX-14
- Explosive initiated via Risi RP3 detonator
- Fragments were recovered in saw dust and magnetically retrieved
- Inertly charged warheads were Mann Barrel tested (-65, 70, 145°F) to validated launch survivability

Embossing in Nose

Nose Embossing Effect on Fragmentation



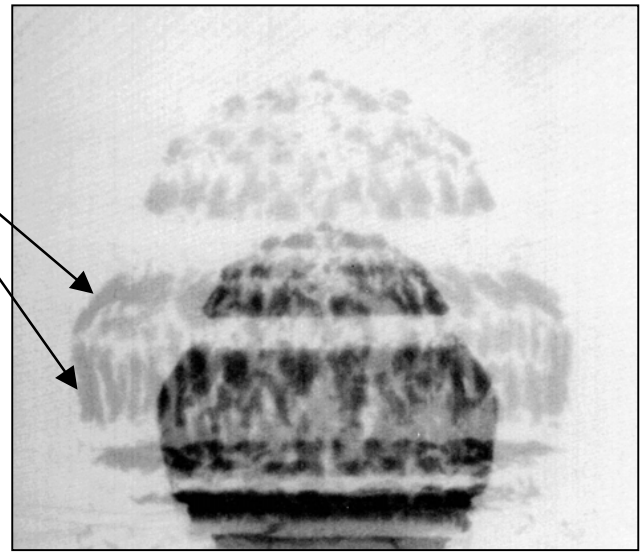
Non-Embossed



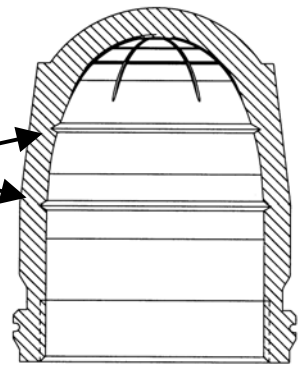
Embossed

Fragments from Nose Embossing

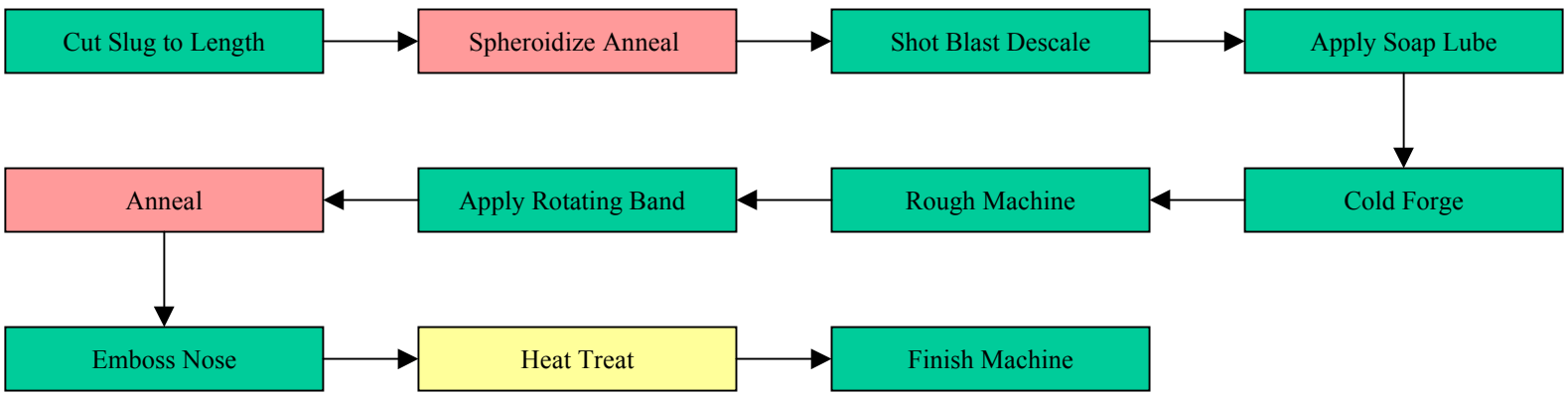
FY00 Effort



Concentric Grooves
Added



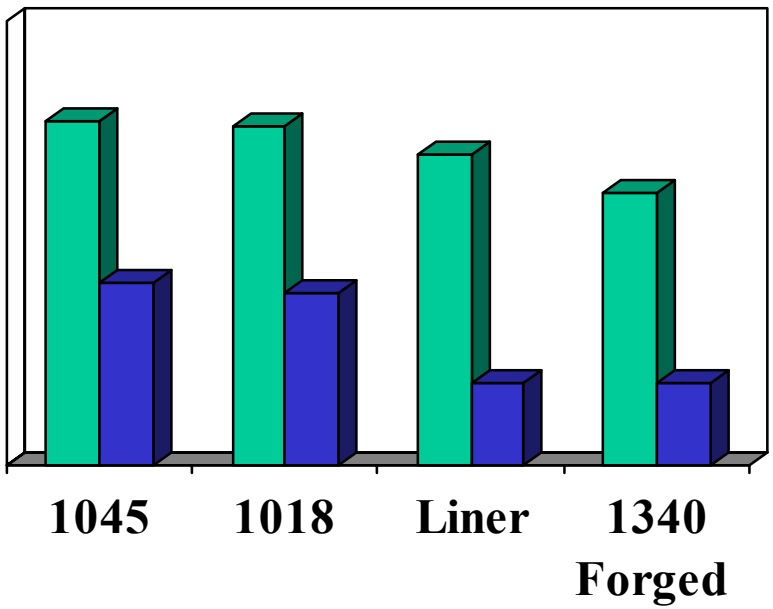
OCSW Warhead Forging Process

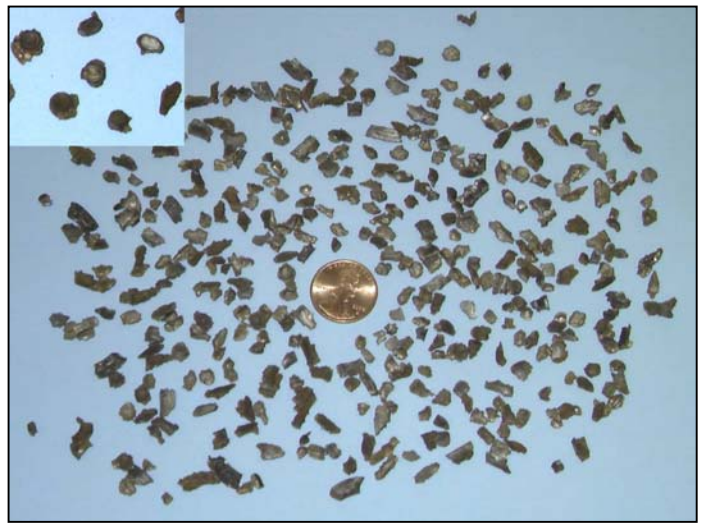


Warhead forging process developed by Medico Industries, Wilkes-Barre, PA

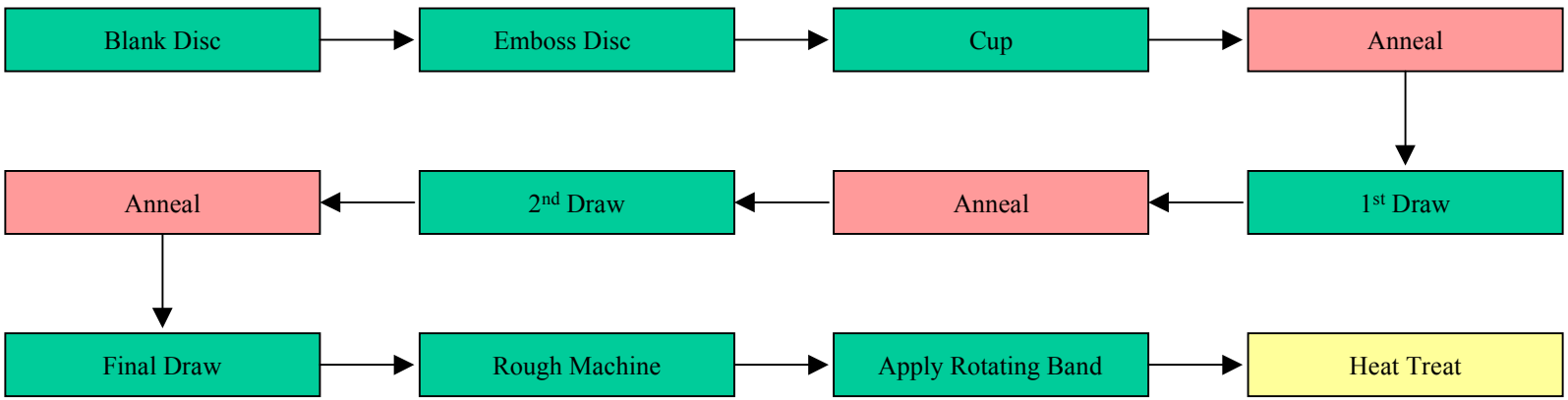
FY00-01 Effort

- Blank, Cup and Draw (BCD) being developed by General Dynamics – Ordnance and Tactical Systems (GD-OTS)
- Process demonstrated with AISI 1018 and 1045
- Fragmentation testing at GD-OTS (Downey, CA) showed 1045 BCD warhead to have the largest percent fragments in the targeted 2-3 grain weight





OCSW Warhead BCD Process



Summary

- Forged warhead process has been demonstrated – AISI 1340 provided best fragmentation
- BCD Process demonstrated – AISI 1045 provided best fragmentation
- BCD process provides largest percent fragments in targeted 2-3 grain weight zone
- Forged process provides broader range of fragment weights
- Process development continuing on BCD process to reduce process cost
- A study of embossing depth/geometry and warhead material is needed to optimize fragmentation